Benefits of Stormwater Management: Increased Property Values

Contents

Overview

A number of studies have estimated the effect that environmental amenities practices have on surrounding property values. Many aspects of land cover, waterbodies, and stormwater management facilities can increase property values, including improved aesthetics, drainage, recreational opportunities, and any aspect that would reduce the owner or tenant's costs (rainwater harvesting, reduced heat island effect, etc.).

Relevant quantitative studies use statistical methods for estimating property value trends from observed data. The hedonic pricing method is commonly used, which involves estimating statistical relationship of a residential property price with measurable environmental qualities while controlling for other housing, demographic, or land cover characteristics. The use of proper statistical methods is important to achieve reliable results. One major consideration is whether studies account for how adjacent or nearby properties are related, termed spatial autocorrelation. If this or other types of autocorrelation are not accounted for, study results may be unreliable if used to assign values to particular environmental features.

While the value of aesthetics is a common consideration, some studies have used statistical techniques and other methods to estimate other values. Braden and Johnston (2004) reviewed a number of studies that estimated values for the following benefits: reduced frequency and extent of flooding, reduced pollution, improved water quality, improved in-stream biological integrity and stream aesthetics, and increased groundwater recharge. For example, Streiner and Loomis (1996) estimated that the value of stormwater management and restoration can increase property values from 3 to 13 percent due to

amenities such as reduced flood exposure, stream bank stabilization and revegetation, debris removal, and other benefits. It is important to consider that increases in property value not only benefit individual property owners, but also can lead to increased tax revenue and general economic improvement, including increased jobs.

The following are summaries of individual research and policy studies that monetize, quantify, or describe property value benefits associated with stormwater management and outline ways in which these benefits can be valued. The summaries are divided into the general types of environmental features studied: Trees and Forest Cover, Stormwater Management Facilities, Improved Water Quality, Riparian Buffers and Stream Restoration, Open Space and Conservation Design, and Wetlands.

Supporting Research

Trees and Forest Cover

GIS-Based Hedonic Pricing of Landscape. Cavailhes et al. (2009)

- Urban fringe of Dijon, France.
- Used hedonic pricing method
- Assessed the effect of landscape characteristics, view, and distance on residential property values.
- GIS data used included satellite images and a digital elevation model.
- Property value was based on 2,667 observations of house sales occurring 1995 to 2002.
- Distance was categorized as six rings of landscape variables, and view was measured in number of cells seen and unseen).
- Statistical analysis controlled for the effects of nearby properties (spatial autocorrelation).
- Within 70 meters from the center of a lot parcel, a 1 standard deviation in increase in the number of visible, tree-covered cells accounted for a 3 percent increase in property value.
- Trees close to houses but not visible by residents provided a third of the estimated value of visible trees.
- Most objects located more than 70 meters away had an insignificant effect.
- Limitations included narrow focus relating to residential consumption and simplification of landscape features.

The value of urban tree cover: A hedonic property price model in Ramsey and Dakota Counties, Minnesota, USA. Sander et al. (2010)

- Dakota and Ramsey Counties, MN; Dakota County urban, suburban, and rural land uses, and Ramsey County urban and suburban land uses.
- Used hedonic pricing method
- Evaluated the effect of tree cover extent and distance on residential property value
- Tree cover was measured as percent tree cover on parcels, and within 100, 250, 500, 750, and 1000 m using the tree canopy data in the National Land Cover Dataset.

- Statistical analysis controlled for the effects of nearby properties (spatial autocorrelation).
- The study accounted for neighborhood effects, development intensity, access to natural areas, and view quality.
- A 10 percent increase in tree cover within 100m resulted in an estimated average sale price increase of $1371 (0.48%); the same cover increase within 250m was estimated to increase sale prices by $836 (0.29%).
- Within parcel tree cover was an insignificant predictor of property value. This result differs from the results of previous studies, and may be explained by the fact that neighborhoods with overall dense tree cover tend to have lots with dense tree cover. After the models controlled for the relationship between nearby properties, the results suggested a weak effect of tree cover within lots on property value.
- The study was limited by land cover data available and did not account for differences in tree canopy composition.

Trees in the city: Valuing street trees in Portland, Oregon. Donovan, G.H. and D.T. Butry. 2010.

- Used hedonic pricing method
- Portland, Oregon
- Within the sample size of 2,608 houses, on average, a house spent 71 days on the market, and had a median price of $259,000.
- Data were collected from these sites on tree diameter, height, type, and other similar variables. Spatial data were also collected based on aerial photographs and cadastral data.
- The results suggest that street trees add an average $8,870 to sales prices and reduce time on market by 1.7 days. The study also suggested the street trees have a positive effect on properties adjacent to those who have street trees. Additionally, more detailed results are discussed relating to tree type and characteristics.
- Spatial correlation was investigated and determined to not have a relevant effect on the results.

Stormwater Management Facilities

The impact of detention basin design on residential property value: Case studies using GIS in the hedonic price modeling. Lee and Li (2009)

- College Station, TX
- Used hedonic pricing method
- Investigated the effect of two different detention basin designs on residential property values:
    - Uniuse flood control detention basins (UDBs)
    - Multi-use detention basin (MDB) – pond integrated with neighborhood park and used as open space or sports fields
- Previous research has found that dry basins can have negative impacts on property values, and some wet basins can have a positive effect. Generally, the literature suggests that aesthetics can play a role in the affect of detention facilities on property value.
- Two real development examples were applied:

    - Woodcreek subdivision: 160 residential properties, two small-size UDBs, a small park and a church are included in the northwest portion of the development.
    - The Edelweiss Estates subdivision: about 600 residential properties, one MDB integrated with two soccer and baseball fields, open volleyball and basketball courts, a jogging and walking trail, a pavilion, and a small parking lot.
- Landscape variables included distances and whether property was adjacent to a park.
- For Woodcreek, properties within view of the detention basin were less expensive than other properties. Distance from the detention basin was found to have an insignificant effect.
- For Edelweiss, distance from the multi-use detention basin was significant. The authors conducted further statistical analysis to estimate that the basin had a significant effect on property value within a 900 foot radius. Property values decreased by an average of $164.82 per 10m (33 ft) away from the MDB. The mean property value was $109,594.42, which suggests a decrease of 0.15% for a distance increase of 10m.
- Study limitations included the small study area (2 developments) and the difference in size between developments. The study did not account for potential variation due to detention basin type or design nor the relationship between adjacent or nearby properties (spatial autocorrelation).

Improved Water Quality

Exploring the hedonic value of ambient water quality: A local watershed-based study. Poor and Paul (2007).

- Used hedonic pricing method
- St. Mary's River Watershed, St. Mary's County, southern Maryland
- Measured the effect of total suspended solids and dissolved inorganic nitrogen on residential property values. No point sources exist in the watershed; nutrient and sediment sources include local farms and stormwater runoff. Development at a military installation in the headwaters is posing a non-point source concern.
- Used housing price data from June 1999 to May 2003 obtained through Metropolitan Regional Information Systems
- Each property was assigned to the closest monitoring station (using a straight-line distance), and linked by the sale year to the corresponding yearly average of the closest monitor's water quality data.
- The results estimated that a one milligram per liter increase in total suspended solids and dissolved inorganic nitrogen decreases property value by $1086 and $17,642, respectively.
- General knowledge of the area's culture supports these findings. The study areas is adjacent to Chesapeake Bay, and according to polls, homeowners in sub-watersheds of the Chesapeake Bay are familiar with water quality issues and willing to pay for improvements.
- Advantages of this study include the application to an entire local watershed and the inclusion of both waterfront and non-waterfront properties.
- No limitations were noted, but one apparent limitation for broader application is that watersheds where the local culture is less dependent on water quality may exhibit a weaker

relationship between housing values and water quality. The study does not discuss whether the relationship between adjacent or nearby properties (spatial autocorrelation) was addressed.

d'Arge and Shogren. 1989. **Okoboji Experiment: Comparing Non-Market Valuation Techniques in and Unusually Well-Defined Market for Water Quality**.

- Used hedonic pricing method among other methods
- Okoboji Lakes in Northwest Iowa
- The lakes provided a comparison of the effects of water quality on property value and other measures of non-market values because cultural and environmental conditions are similar between the two lakes while they differ in water quality.
- Three methods for estimating the value of water quality were applied and compared:
    - A site valuation based on differing property values across
    - A contingent valuation of willingness to pay for water quality changes.
    - An analysis of realtors' interpretations of observed price differentials
- The sample sizes for each method were: 66 for the property valuation (39 for West Okoboji and 27 for East Okoboji-about 10 % of the residences in the Lakes region); 20 for the contingent valuation experiment (3% of households); and 17 realtors and real estate agents (15% of total agents).
- The results for each method are similar in magnitude; the value of water quality ranged from 13 to 23% of the total residence value per square foot of private residence, accounted for by water quality increasing from a qualitative boating/fishing level to a qualitative perceived swimming/drinking level.
- Similar to Poor and Paul (2007), the residents tend to have a strong awareness of water quality due to the importance of the lakes within the local culture. The paper describes this as a "notably active and unusually well-defined market" for water quality.

Epp and Al-Ani. 1979. **The Effect of Water Quality on Rural Nonfarm Residential Property Values**.

- Used hedonic pricing method
- Small rivers and streams in Pennsylvania
- Selected 12 paired locations on streams near water quality stations and with consistent real estate and environmental characteristics other than water quality; Focused on rural, non-farm residences.
- Tested several water quality constituents: pH, dissolved oxygen, biochemical oxygen demand, acid from minerals, and acid from carbon dioxide, nitrate, and phosphate.
- Constituents with significant effects on property value were pH, acid from minerals, and acid from carbon dioxide.
- Both measured water quality and owner's perceptions of water quality were significant predictors of property value.
- Measured pH was a significant predictor of property value for streams within the normal range (6.5 to 8.5) but not below the normal range (3.7 to 5.5.). The suggested explanation for this

result was that pH changes within the normal range affect recreational uses of the streams, while changes below the normal range do not have additional effects on recreation uses.
- The results also suggest that increased flooding hazard decreases property value for polluted streams; flood hazard did not have a significant effect on property value for streams within normal ranges of water quality, defined as clean.

Steinnes, D.N. 1992**. Measuring the economic value of water quality**.

- Used hedonic pricing method.
- Lots on 53 lakes leased by the Minnesota Department of Natural Resources.
- Property value data were obtained by using market appraisal methods.
- Three price variables were tested: price of all lots on lake (TPRICE); average price per lot on lake (PPERLOT); and average price per front foot on lake (PPERFF).
- The following water quality variables were tested: the percentage littoral (shallow water); a measure based on amount of suspended organic material in water, and the number of feet below the surface a secchi disc reading can be observed (secchi depth). Secchi depth was found to be the most significant variable.
- An increase in one foot of secchi depth was estimated to increase property values by $206 to $240.
- Results suggest that economic value may be attached to a perceived, rather than actual, measure of water quality.
- The limitations of this study include the use of appraised values instead of actual sales values. The independent variables tested were small in number and may not provide sufficient control for other variables affecting property values.

Johnston and Braden (2008) **use two case studies to demonstrate economic benefits (WTP) of environmental improvement including baselines for flood reduction and environmental clean-up.**

- In one case study the authors examined benefits that can be construed as having purely utilitarian value of reduced damages due to flooding of Blackberry Creek watershed in south-central Kane County and north-central Kendall County, Illinois.
- For Blackberry Creek the sum of the downstream flood mitigation and infrastructure benefits amounts to $380–590 per developed acre following conservation design principles; based on assessment of property value differentials
- Using benefits transfer methods as outlined by Braden and Johnston (2003), conservation design practices generate a total benefit based on property value of $391,600–2,488,500 over the downstream study area based on the location of the properties within the 100-year floodplain generated by the two scenarios. These values range between 0.4 and 2.5% of affected property value.
- A second case study looks at the effects of a contaminated harbor site on property values

- For Waukegan homeowners, mean WTP is $436 million (median $462 million) for full harbor cleanup, realized as an increase in residential property values; partial cleanup was worth considerably less: mean aggregate WTP of $158 million (median $158 million)
- Overall, the authors conclude that "Differences in property values associated with different levels of environmental quality suggest that those differences are first perceived by residents (however indirectly), that the perceptions are realized in different levels of willingness to pay, and those levels represent a potentially large portion of overall property values (2.5% baseline for flood reduction only, 18% for environmental cleanup)."

Open Space and Conservation Design

Crompton. 2001. **The Impact of Parks on Property Values: A Review of the Empirical Evidence**.

- Literature review of 25 studies investigating the effect of park proximity and property value.
- 20 out of 25 reviewed studies provided evidence to support that proximity to parks contributes to increases in property values.
- Based on the review, the authors suggest that a 20 percent increase in property value for properties abutting or fronting a passively-used park. If more active recreation, like sports activities, occurs at the park, the study suggests that the percent will be lower, and if the park is passive and large, the percent will be higher.

DesRosiers et al. 2002. **Landscaping and House Values: An Empirical Investigation.**

- Used hedonic pricing method
- Quebec, Canada
- Evaluates the effect of landscaping on house values.
- Conducted a detailed field survey of 760 single-family homes sold between 1993 and 2000 on the territory of the Quebec Urban Community. Applied thirty-one landscaping attributes of both houses and their immediate environment. Sale prices ranges from $50,000 to $435,000, with the mean price standing at $112,000.
- Statistical analysis controlled for the effects of nearby properties (spatial autocorrelation).
- The study found that increased tree cover (within reasonable limits) between a property and its immediate neighborhood, can result in increases in property value. This effect appeared more pronounced in communities with a high proportion of retired residents. Other landscape features, including various planting scenarios, also had a significant positive effect on property value.
- The study discusses several limitations. The data used do not account for potential landscaping improvements occurring between the transaction date and the survey period, which would distort the results. The data did not allow for controlling the link between homeowners' preferences for landscaping features and their socio-demographic and economic profile. The researchers' next step was to conduct an additional survey to collect this information.

Johnston et al. 2006. **Downstream Economic Benefits of Conservation Development**.

- The study watershed was located in south-central Kane County and north central Kendall County, a rapidly developing area near Chicago, IL.
- Two scenarios were modeled: a conservation-design scenario, based on implementing the 2020 Resource Plan published by Kane County, and a conventional development scenario, based on existing local municipal plans.
- Flood risk for downstream census block groups was determined using HSPF and HEC-RAS models. The most extreme flood event affecting property value was assumed to be the 100-year flood event (0.01 annual probability; the cutoff for land to be included in the National Flood Insurance Program).
- Two non-market valuation approaches were used:
    - Benefits transfer techniques, using the assumption that residential property values are reduced by an average of 2 to 5 percent by exposure to flooding and that property values are reduced by an average of 0 to 2 percent when flooding is reduced, as reported by Braden and Johnston (2004).
    - Flood damage formula-based approaches used by the U.S. Army Corps of Engineers.
- For property value estimates, the study used area-weighted median housing values by census block group as reported by the 2000 U.S. Census. The area-weighted median housing value was $175,600 per unit for homes in the census block groups within the flood risk areas.
- Using the benefit transfer method, it was estimated that conservation-design would increase downstream property values by the following percentages of the value of affected properties, depending whether or not they remain in the 0.01 annual probability flood zone:
    - Benefits transfer method: 0.4 to 2.5%
    - Flood damage method: 1.7–2.5%
- The following values for conservation design were attributed to developed acres upstream of the flood hazard areas:
    - Benefits transfer method: $40 to $250 per developed acres.
    - Flood damage method: $110–158 per developed acres.
- Study limitations included the use of one flood event (100-year) versus a range of flood events. The use of parcel-level or other more detailed property value data may provide different results. The study focused on flood hazard benefits whereas water quality, ground water recharge, and habitat values of conservation design may also be realized.

Kaplan et al. 2004. **Open Space Communities: Resident Perceptions, Nature Benefits, and Problems with Terminology.**

- Survey of relative importance of landscape features
- Survey approach, no hedonic or contingent valuation methods, no quantified benefits

Sander and Polasky. 2009. **The value of views and open space: Estimates from a hedonic pricing model for Ramsey County, Minnesota, USA**

- Used hedonic pricing method

- Ramsey County, MN in the Minneapolis-St. Paul area; urban county of roughly 500,000 residents.
- Dataset consisted of 4918 single-family residential properties; 2005 mean and median sale prices for single-family residential properties were $255,955 and $222,000, respectively (range was $65,000 to $1,740,000).
- Viewsheds were calculated in GIS to assess the distance and characteristics of residential views with a maximum distance of 1 kilometer.
- The study results suggest that home sale prices increase significantly with closer proximity to parks, trails, lakes, and streams, with lake exhibiting the greatest impact. Within the 1 km radius of study, reducing view distances by 100m had the following effects on mean home sale price:
    - Lakes: $216
    - Streams: $127
    - Parks: $136 (using road distance)
    - Trails: $119 (using Euclidian distance, "as the crow flies")
- Forest views had a positive but insignificant effect on property values. A reason for this result may be that trees restrict views of other landscape features. One limitation of this study was that tree cover within residential areas was not included as a variable.

Ward et al. (2008) **use real estate data and hedonic analysis to determine impact of LID on property values in Seattle neighborhoods.**

- A preliminary analysis of the effect of LID on property values in Seattle indicates that the introduction of LIDs increased property values by 3.5 – 5 percent.
- Compared to similar houses (e.g., in terms of square feet of living space, building quality, lot size, etc.) in the same zip-code, houses in Seattle's Street Edge Alterative (SEA), Broadview Green Grid, Pinehurst Green Grid, and High Point projects sold for 3.5-5 percent more during the period after the adjacent streets were converted to LID.
- High Point project represents a large development of new homes, while the other projects changed the streets and drainage systems but did not involve building new homes.
- The homes in the SEA, Broadview, and Pinehurst projects sold for 4.3% more than similar homes in the same neighborhoods, but the effect is only marginally significant at standard levels. The homes in the High Point project sold for a more statistically robust 5.1% premium over other homes in the same neighborhood.
- Results suggest people are willing to pay for the combination of neighborhood amenities and environmental services provided by LID stormwater controls.

Wiley et al. (2010) **consider the relationship between energy-efficient design and the leasing/sales markets for commercial real estate. They use an economic model that considers lease rates and occupancy in simultaneous equilibrium.**

- The authors use a national sample of 46 office markets across the USA with data available for Energy Star-labeled and LEED-certified properties

- The authors hypothesize that if green buildings demonstrate superior rent and occupancy potential in the leasing market, then they must also earn a premium in the sales market for commercial office space. Three economic explanations are provided for this:
    - The potential for green office space to command higher rents
    - The enhanced ability of a green building to attract desirable tenants (i.e., improved occupancy)
    - The direct impact of savings in operating expenses.
- Results from this study indicate that "green" buildings achieve superior rents and sustain significantly higher occupancy. The improved performance in the rental market is reflected in a significant premium for the selling price of Energy Star-labeled and LEED-certified properties
- The results provide evidence that green-labeled buildings achieve significantly higher rents—estimated at 7.3 to 8.6% for Energy Star properties and 15.2 to 17.3% for LEED-certified properties. Simultaneously estimated occupancy levels are higher by approximately 10 to 11% for Energy Star properties and 16 to 18% for LEED-certified properties.

- Energy Star-labeled and LEED-certified properties sell at significant premiums to comparable properties; $30 and $129/ft2, respectively

White and Leefers. 2007. **Influence of Natural Amenities on Residential Property Values in a Rural Setting.**

- Used hedonic pricing method
- Wexford County, Michigan; northern Lower Peninsula of the state
- Between 1990 and 2000, a sharp increase in both population (15.6%) and number of households occurred within the county. Average population density remains low at 53.9 people/square mile, compared to 175 people/square mile statewide, and the county contains 73 percent forested land.
- Indicates that prior to this paper, most hedonic studies of this nature have been conducted in urban settings.
- A sample size of 267 parcels was used.
- Hedonic pricing models were developed for two rural residential parcel types: developed parcels located in subdivisions (S), and developed parcels not located in subdivisions (NS) with the following characteristics:
    - Average size: 8.6 acres for NS, 1 acre for S
    - Average distance from forest 47 feet for NS, 322 for S
    - NS parcel sales prices ranged from $3,000 to over $300,000; S parcel sales prices ranged from $14,000 to $475,000
- The variables pertaining to natural amenities were: distance to nearest public or private forested land, distance to Lake Mitchell, distance to the nearest publicly owned land, distance to the National Scenic River, and distance to the nearest stream.
- For NS parcels, proximity to forest had a negative, significant effect on property value. NS parcels located 500 feet from the nearest forested land sold for nearly $19,000 more than

similar parcels with forested land on the property. Forest was the only natural feature with a significant effect on property value for NS parcels.

- For S parcels, forest had a positive but insignificant effect. Proximities to neighborhood parks and lakes had a positive, significant effect on property value.
- Since other research in nearby less-forested areas has indicated forest to have a positive influence on property value, the authors suggest that, due to the high density of forest in Wexford County, residents may not perceive forest as scarce commodity and are not willing to pay a premium for it; in contrast, lots with less view of forest may be perceived as a scarce commodity in the county.
- One limitation of this study was that the parcel dataset did not provide for detailed variables typically used in hedonic studies (e.g., number of bathrooms). A dummy variable indicating whether or not a house had multiple floors was used to approximate the effect of other housing characteristics. However, this variable may not be controlling for all important housing characteristics.
- The study does not discuss whether the relationship between adjacent or nearby properties (spatial autocorrelation) was addressed.

Wetlands

Reynolds and Regalado. 2002. **The Effects of Wetlands and Other Factors on Rural Land Values**.

- Four counties in southwest Florida: Desoto, Hardee, Highlands, Manatee
- Used data from 212 sales of rural land occurring 1988 through 1993
- Data on wetlands was obtained from the National Wetlands Inventory (NWI) maps and represented three major types: palustrine, riverine, lacustrine.
- The results suggested that lacustrine wetlands had no significant effect on rural property value, and riverine and emergent and forested palustrine wetlands have a negative effect on rural property value. Palustrine scrub-shrub wetlands were shown to have a positive effect on rural land prices.
- One limitation is that riverine and lacustrine wetlands were underrepresented; it is also suggested that future studies incorporate more information on specific wetland characteristics and landowner preferences for these characteristics. The limited accuracy of the NWI may also be a limitation, especially since it was used at the parcel scale.
- The study does not discuss whether the relationship between adjacent or nearby properties (spatial autocorrelation) was addressed.

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